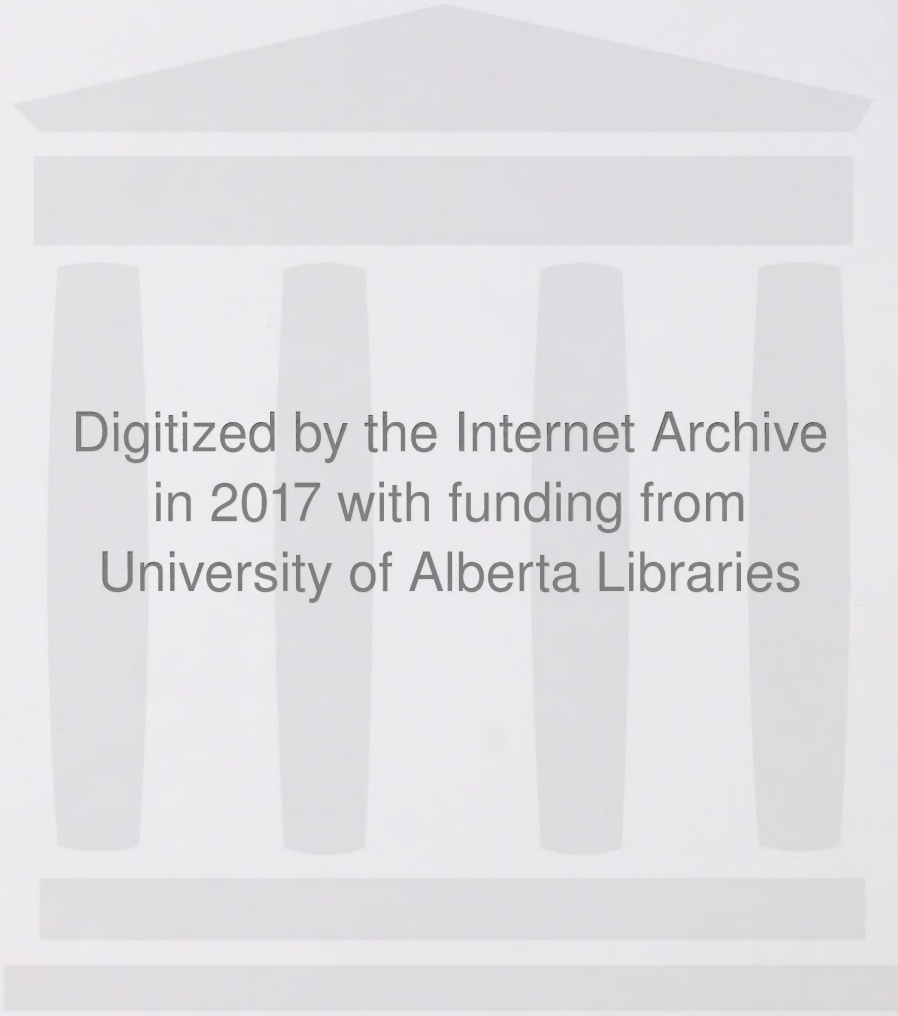
University of Alberta Library
0 1620 3502940 2

Science 4

Building Devices and Vehicles That Move

Alberta
EDUCATION

Learning
Technologies
Branch


Digitized by the Internet Archive
in 2017 with funding from
University of Alberta Libraries

https://archive.org/details/science402albe

Science 4

Building Devices and Vehicles That Move

2

Module 2 · Science 4 · Module 2 · Science 4 · Module 2 · Science 4 · Module 2 ·

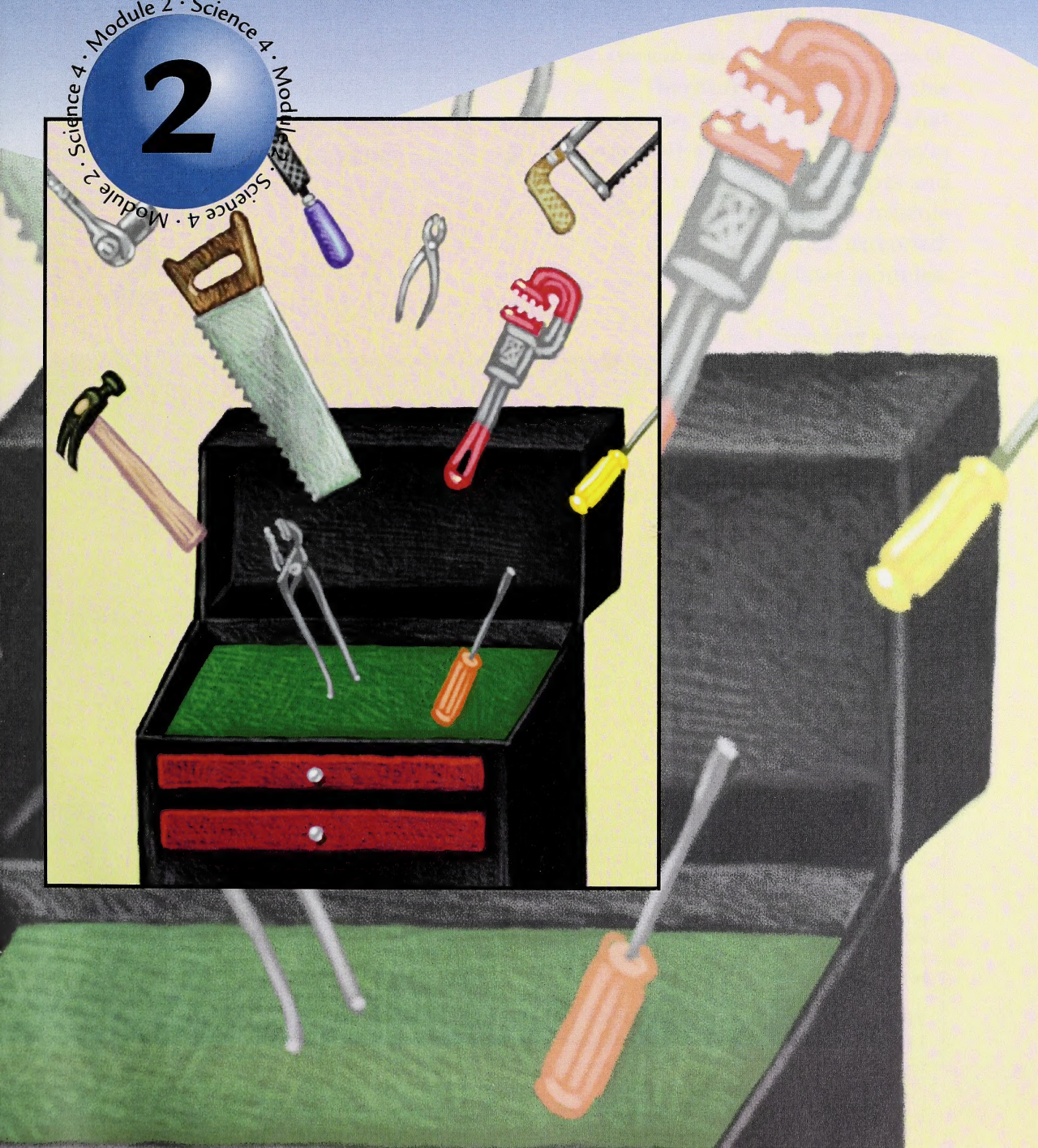


IMAGE CREDITS

All images in this courseware were created by or for Alberta Education unless noted below or in subsequent lesson Image Credits.

Cover: Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission. **Welcome page:** *background* Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.; **Contents pages:** *background* Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.; **Pages 6 and 7:** *background* Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.; **Page 8:** *both* "© 2006 Jupiterimages Corporation"; **Page 33:** Eyewire Collection/Getty Images; **Page 34:** © 2005–2006 www.clipart.com; **Page 35:** *hand* © 2005–2006 www.clipart.com; **Page 36:** Eyewire Collection/Getty Images; **Page 55:** Eyewire Collection/Getty Images; **Page 57:** *all* Artville/Getty Images; **Page 58:** Photodisc Collection/Getty Images; **Page 76:** Photodisc Collection/Getty Images; **Page 79:** Digital Vision/Getty Images

All other image credits in this resource constitute a continuation of this copyright page.

Science 4
Module 2: Building Devices and Vehicles That Move
Student Module Booklet
Learning Technologies Branch
ISBN 0-7741-2852-6

The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Student Module Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	✓
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Education, **http://www.education.gov.ab.ca**
- Learning Technologies Branch, **http://www.education.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.education.gov.ab.ca**

Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Copyright © 2006, Alberta Education. This resource is owned by the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, 10155 – 102 Street, Edmonton, Alberta, Canada T5J 4L5. All rights reserved.

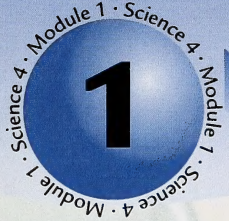
No part of this courseware may be reproduced in any form, including photocopying (unless otherwise indicated), without the written permission of Alberta Education. This courseware was developed by or for Alberta Education. Third-party content has been identified by a © symbol and/or a credit to the source. Every effort has been made to acknowledge the original source and to comply with Canadian copyright law. If cases are identified where this effort has been unsuccessful, please notify Alberta Education so corrective action can be taken.

THIS COURSEWARE IS NOT SUBJECT TO THE TERMS OF A LICENCE FROM A COLLECTIVE OR LICENSING BODY, SUCH AS ACCESS COPYRIGHT.

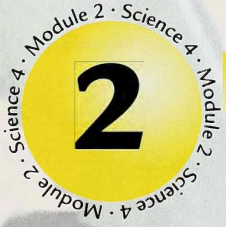
UNIVERSITY LIBRARY

Welcome

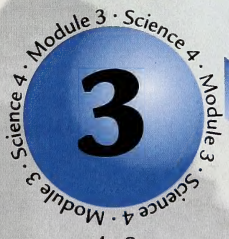
to Module 2 of Science 4



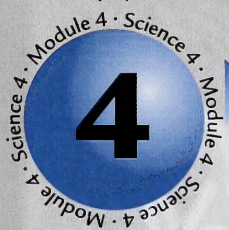
Module 1
Wheels, Gears, and Levers



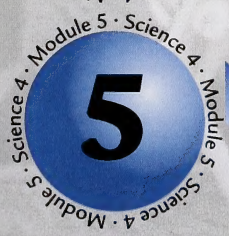
Module 2
Building Devices and Vehicles That Move



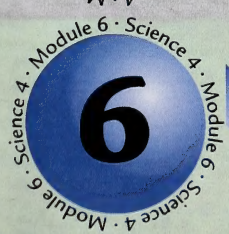
Module 3
Light and Shadows



Module 4
Plant Growth and Changes



Module 5
Waste and Our World



Module 6
Relationships

There are six modules in this course. It is recommended that you work through the modules in order because the concepts and skills introduced in one module will be reinforced, extended, and applied in later modules.

Module 1 contains general information about the course components, additional resources, icons, assessment, and strategies for completing your work. If you do not have access to Module 1, contact your teacher to obtain this important information.

Contents

Module Overview 6

Section 1: Forces That Move Us 8

Lesson 1: Wind and Water 9
Activity 1: Cleaning by Force 15
Lesson 2: Downhill Ride 20
Activity 2: Sliding Away 22
Lesson 3: Winding It Up 28
Activity 3: Driving a Spool 30

Section 1 Conclusion 33
Optional Follow-up Activities 34

Section 2: A Designer at Work 36

Lesson 4: Design Work 37
Activity 4: Problem Solver 42
Lesson 5: Designing a Machine 50
Activity 5: Designing with Pulleys 51

Section 2 Conclusion 55
Optional Follow-up Activities 56

2

Building Devices and Vehicles That Move

Section 3: Building and Refining the Design 58

Lesson 6: Testing, Testing 59
Activity 6: Building and Testing 62
Lesson 7: Improving Your Machine 65
Activity 7: Making a Better Burglar Alarm 67
Lesson 8: Final Testing 71
Activity 8: Are We Done Yet? 73

Section 3 Conclusion 76
Optional Follow-up Activities 77

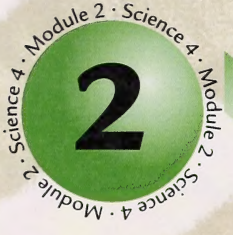
Module Summary 79

Glossary 80

Module Overview

Have you ever wondered if there was a better way to do something? Perhaps you wished for a better machine or an easier method for doing a task. Although machines can't do your homework for you, they can do a lot of other things. And someone, somewhere, had to come up with the idea for each machine. Then he or she had to design, build, and test the machine.

In this module, you will design, build, and test a machine of your own.

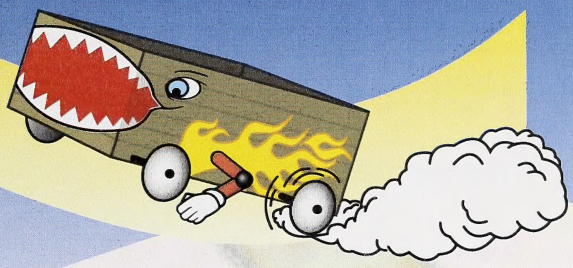


Module 2
Building Devices and Vehicles That Move

Section 1
Forces That Move Us

Section 2
A Designer at Work

Section 3
Building and Refining the Design



How Will You Be Marked?

Your mark on this module will depend on how well you complete the two Assignment Booklets.

This is how the marks are distributed:

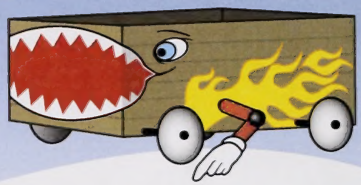
Assignment Booklet 2A	
Section 1 Assignment	22 marks
Total	22 marks
Assignment Booklet 2B	
Section 2 Assignment	39 marks
Section 3 Assignment	23 marks
Total	62 marks

Be sure to check with your teacher to see if this mark distribution is appropriate for you. Some teachers like to include other reviews and assignments. When you get the assignments back from your teacher, be sure to read the comments and talk about them with your home instructor.

When you do the assignments, work slowly and carefully under the instruction of your home instructor or teacher. You may use your course materials to help you, but you must do the assignments by yourself.

Section 1

Forces That Move Us



Introduction

You use forces all the time. Some examples would be when you lift this booklet, push yourself away from a table, or cross a room.

Sometimes you can easily see the force you are applying. For example, the stylist presses on the handles of the scissors and your hair gets cut.

Other forces are not as easy to see. For instance, you cannot see the force that holds you on Earth (or at least brings you back when you jump up).

You will find out about different types of forces in this section.

Lesson 1: Wind and Water

Looking at Forces

What forces have you used today?
Did you push open a door? Did you get
to throw a snowball? Did you lift a milk carton and pour some milk into a glass?

force: a push or a pull acting on an object

Each of these activities involved forces. You applied a force to an object, and the object also applied a force to you.

Today you will study the forces at work around you.

When you push or pull something, you are applying a force. You may make something move or stop it from moving. You might also make it change direction.

Pushing on the large ball of snow gives it extra energy.

Catching the ball takes away energy from the moving ball.

Hitting the tetherball changes its direction. It may add or remove energy from the moving ball.

In curling, turning the handle as you release the rock changes the path the rock takes.

Turning the handles on a bicycle changes the bicycle's direction.

Digging your feet into the snow removes energy from the moving toboggan.

Suppose you want an object to move faster. You add energy with a force. For instance, if you want your bicycle to move faster, what do you do? That's right! You pedal harder. You also pedal harder if you want to increase the speed on a stationary bicycle.

resist: to act against an applied force

Use the palm of your hand to push hard on a closed door. The door will **resist** your push. When you push on the door, the door also pushes on you. There may be red marks on your hand from the door. These marks help show you that the door applied a force on you.

People have known about forces, like wind and water, for centuries. We have learned how to use these forces to help us.

Using Wind

How can wind be used? One example is using sails on boats. The sails catch the wind and use it to push the boat. What a great idea! Put up a sail and let the force of the wind push you along.

Using sails takes less physical effort than rowing the boat. There can be some problems though. What happens if the wind is too strong or if there is no wind? What happens if the wind is not blowing in the direction you want to go?

There are other ways to use sails to capture the force of the wind.

Perhaps you've seen pictures of Dutch windmills. In Holland, people used windmills to grind their grain. The arms of the windmill have small sails to catch the wind. Wind makes the arms spin around like the hands of a clock. The motion causes a stone wheel to turn at the bottom of the windmill. The stone wheel crushes and grinds the farmer's grain.

You have likely seen and played with a pinwheel like the one shown in the diagram. This is just a fun windmill toy. The faster the wind blows, the faster the vanes of the toy spin!

Have you seen windmills like these?

In some parts of Alberta, windmills like the ones in the photo are used to make electricity.

Some windmills in Alberta use wind power to pump water. Farmers can save gas or electricity costs.

Using Water

Moving water can also apply a lot of force. Have you ever swum in a river? Some rivers move slowly and lazily, and you can swim easily in them. What if the water speed is increased? For example, if the water is rushing quickly in rapids or flowing down a sharp slope such as a waterfall, the force on a swimmer will be greater, making swimming harder or even dangerous.

You can feel the force of moving water in the kitchen or bathroom. Let water from a cold-water tap run full force. Put your hand under the running water.

Can moving water turn on a light or make your electric stove work? In some places, the energy in falling water is changed into electricity. Water is stored behind a dam. Some of this water flows through the dam to a power plant. Here, the water turns a **turbine**.

turbine: a large wheel rotated by the force of moving steam, water, or other fluid

generator: a machine that changes water power, steam power, or other kinds of mechanical energy into electricity

A turbine is a special kind of water wheel. The spinning turbine powers an electric **generator**. Entire cities can have electricity, thanks to the force of falling water.

There is a good diagram showing an electrical generating plant powered by water on the How Stuff Works website.

http://science.howstuffworks.com/hydropower-plant1.htm

Activity 1: Cleaning by Force

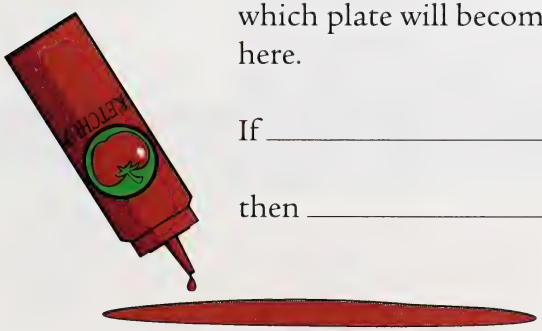
How does the speed of water flow affect the cleaning of an object? Perform this activity to find out!

What you need

- about 30 mL ketchup
- 2 white or light-coloured plates
- a watch or clock that measures seconds
- access to a sink with cold running water

What to do

Ask an adult to help you with this activity.



1. Pour equal amounts of ketchup onto each plate. Predict which plate will become clean faster. Write your prediction here.

   If _____,

   then _____.

2. Turn on the cold water tap so that the water runs gently. Hold one plate under the running water so that the ketchup is approximately 15 cm below the faucet. Time how long it takes for the gently running water to clean the plate.

Time: _____ seconds

3. Increase the rate of water flowing from the tap. The water should be running quickly. Again, use only cold water. Hold the second plate in the same way under the running water so that the ketchup is approximately 15 cm below the faucet. Time how long it takes for the rapidly running water to clean the plate.

Time: _____ seconds

4. Did your results match your prediction?

_____

5. Explain why there was a difference in the times needed to clean the two plates.

_____

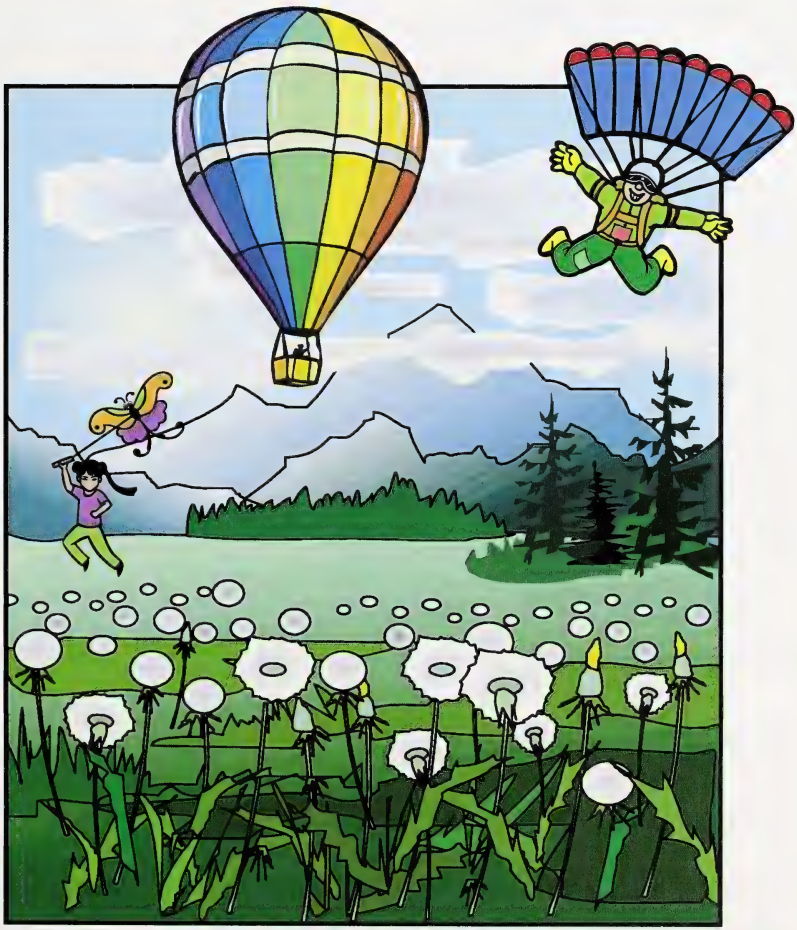
_____

_____

Check your answers for this activity in the Suggested Answers at the end of this lesson.

Wind and moving water are examples of forces. Most of the time, you can see the effect of these forces. For example, wind fills a sail and sends a boat zipping across the water. Air fills a hot-air balloon, kite, and parachute, and these are carried by the wind. Plant seeds, too, may be carried by the wind (you will find out more about this in Module 4).

As well, with many forces there is contact between objects. Wind fills a sail, you push a mop, or water spins a water wheel. Not all forces are that direct. You will discover more about these other types of forces in the next lesson.



Turn to Assignment Booklet 2A and complete question 1 of the Section 1 Assignment.

Suggested Answers

Activity 1: Cleaning by Force

1. Pour equal amounts of ketchup onto each plate. Predict which plate will become clean faster. Write your prediction here.

   This is one possible answer. Your prediction may have been different.

   If the water runs faster,

   then the plate will become clean faster.

2. Turn on the cold water tap so that the water runs gently. Hold one plate under the running water so that the ketchup is approximately 15 cm below the faucet. Time how long it takes for the gently running water to clean the plate.

   The length of time it takes will vary.

3. Increase the rate of water flowing from the tap. The water should be running quickly. Again, use only cold water. Hold the second plate in the same way under the running water so that the ketchup is approximately 15 cm below the faucet. Time how long it takes for the rapidly running water to clean the plate.

   The length of time it takes will vary. However, this plate should clean faster than the one put under gently running water.

4. Did your results match your prediction?

   Answers will vary.

5. Explain why there was a difference in the times needed to clean the two plates.

   When the water runs faster out of the tap, the force of the water is greater. The greater force will remove the ketchup faster.

Key Words

force: a push or a pull acting on an object

generator: a machine that changes water power, steam power, or other kinds of mechanical energy into electricity

resist: to act against an applied force

turbine: a large wheel rotated by the force of moving steam, water, or other fluid

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

9 "© 2006 Jupiterimages Corporation"

10 **all:** © 2005–2006 www.clipart.com

11 **top left:** Digital Vision/Getty Images
top right, middle, and boy: © 2005–2006 www.clipart.com

12 **left:** Copyright © 2006 Alberta Education and its licensors. All rights reserved.
right: "© 2006 Jupiterimages Corporation"

13 **top:** © 2005–2006 www.clipart.com
middle: Photodisc/Getty Images
bottom: "© 2006 Jupiterimages Corporation"

14 "© 2006 Jupiterimages Corporation"

15 © 2005–2006 www.clipart.com

17 **all:** © 2005–2006 www.clipart.com

Lesson 2: Downhill Ride

Have you ever skied or ridden a bike down a steep hill? What did you notice about your speed? Today you are going to explore downhill motion and the force behind it.

gravity: a force of attraction between objects

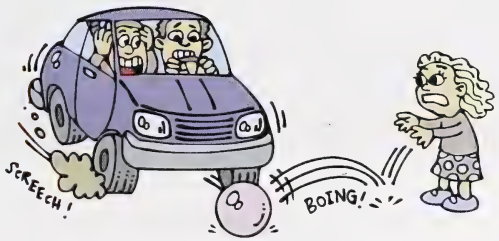
If you drop a ball, it falls because of the force of gravity. Gravity is a force that pulls objects together. When you dropped the ball, did you see Earth move toward it? Probably not; you only saw the ball move toward Earth. Earth has a much stronger gravitational force than little things like a ball. Earth's strong gravitational force pulls objects toward it. That is why we don't float off into space; gravity holds us on Earth!

inertia: the tendency of objects to remain in motion or to stay at rest

When an object is already resting, it takes a force to make it move. This is called **inertia**. Inertia keeps objects at rest until a force is applied to them. It also keeps objects moving until a force is applied to stop them! Have you ever been standing on a bus when it stopped suddenly? You would have kept moving toward the front of the bus. This is inertia, keeping you moving until something stops you.

When you are riding in a car and the car stops, do you keep moving? Perhaps if the stop is very fast you do. Most of the time you stop too. Why don't you keep moving? What helps you to stop along with the car? It is another invisible force called **friction**.

friction: a force that opposes the motion of an object



Today you are going to overcome friction. You will use the force of gravity to move objects downhill.

Activity 2: Sliding Away

You are going to experiment with gravity and friction. You will be changing the slope of a ramp. You will find out how steep a slope is needed to start an object moving. Does the weight of the object affect how big a slope is needed? You are going to find out.

You will have to choose your objects with care. Would a heavy ball and a lightweight box be a good choice of objects to compare? No, their shapes are too different. Try to use similar objects that have different weights. For instance, use two soup cans, with one empty and the other full. You could stand them on end or lay them on their sides. Is it easier to roll them down the ramp than to slide them down?

Please ask your home instructor for help with this activity. You will need help finding suitable small objects. You will also need help to measure and record the height of the ramp when the first object of each pair moves.

What you need

- a ramp*
- a number of pairs of small objects**
- a metre-stick or metric tape measure
- a pen or pencil

* a flat, rectangular piece of smooth wood or heavy cardboard approximately 1 m long and 20 cm (or more) wide

**Objects should have the same size and shape but different weights: books, blocks, boxes, cans, and so on. Do not use breakable items. Small boxes may be filled with items having different weights (for example, cotton balls and rice).

What to do

1. Lay the ramp (the piece of smooth wood or heavy cardboard) flat on the floor. Label one end of the ramp "START."

2. Choose two objects and describe them in the first column of the following chart. The objects should be the same size and shape, but have different weights.

   Ask an adult to help you find suitable small objects.

Description of Objects (size, weight, shape, position)	Height of "START" end of ramp when the first object begins to move			Observations (Which object moves first? Does the second object move soon after the first?)
	Trial 1	Trial 2	Trial 3	

3. Place the pair of objects on the ramp at the "START" point.

   Line up the front edges of the objects. Make them the same distance from the far end of the ramp.

4. You have several things to do in this step. Repeat this part of the experiment several times for each pair of objects. This lets you be sure of your results.

   - Slowly begin to lift the "START" end of the ramp. Keep lifting slowly until the objects begin to move.
   - Record which object moved first.
   - Record the height of the ramp when the first object began to move.

5. Do the same test with other pairs of objects of differing sizes, textures, weights, positions, and shapes. Record your results.

6. What conclusions do you come to after this experiment?

_____

_____

_____

_____

Check your answers for this activity in the Suggested Answers at the end of this lesson.

A Great Scientist

Sir Isaac Newton

physics: the science that studies matter and energy, and how they interact

Sir Isaac Newton is often called the founder of modern physics. Physics is the study of matter and energy. Light, heat, sound, electricity, magnetism, and movement of objects are studied in physics.

Newton was born in 1642 to a farming family. He was a careful observer. He described many rules (laws) about mathematics and physics. The rules are still used today. He is perhaps best known for one of his rules about gravity. Newton began thinking about gravity after seeing an apple fall from a tree. Some stories say that the apple actually fell on his head! Newton was curious. Why did the apple fall? Newton studied this question. He decided that a force caused the apple to move. He called the force *gravity*.

Newton's laws of gravity are easy to understand. All objects are attracted to each other by the force of gravity. The size of the force depends on two things: the masses of the objects and how far apart they are. This means that the bigger the objects are, the stronger the force will be. An example would be Earth and the Sun. The attraction between Earth and the Sun is strong. This force of gravity is what keeps Earth circling around the Sun.

In 1708 Newton was made a knight because of his work in science. He died in 1727.

Turn to Assignment Booklet 2A and complete question 2 of the Section 1 Assignment.

Suggested Answers

Activity 2: Sliding Away

2. Choose two objects and describe them in the first column of the following chart. The objects should be the same size and shape, but have different weights.

Ask an adult to help you find suitable small objects.

Answers will vary. An example is shown in the following chart.

Description of Objects (size, weight, shape, position)	Height of "START" end of ramp when the first object begins to move			Observations (Which object moves first? Does the second object move soon after the first?)
	Trial 1	Trial 2	Trial 3	
full pop can empty pop can both sitting upright	12 cm	15 cm	13 cm	They seem to move about the same time.

6. What conclusions do you come to after this experiment?

Your answers may be similar to these:

- Objects with smoother bases begin to slide sooner than objects of the same weight with rough bases.
- Objects that roll begin to move at a lower height than objects that slide.

Key Words

friction: a force that opposes the motion of an object

gravity: a force of attraction between objects

inertia: the tendency of objects to remain in motion or to stay at rest

physics: the science that studies matter and energy, and how they interact

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

20 "© 2006 Jupiterimages Corporation"
21 **all:** © 2005–2006 www.clipart.com
22 © 2005–2006 www.clipart.com
25 © 2005–2006 www.clipart.com

Lesson 3: Winding It Up

As a small child, did you have a toy that you could wind up? Perhaps you had a jack-in-the-box or a wind-up robot or doll. There are many items that are powered by winding or cranking. Today you will examine some of them, and see how they work.

Try viewing some of the wind-up and natural forces toys in the movies on this website.

http://www.vam.ac.uk/vastatic/microsites/1482_moving_toys/

Have you seen an early car such as the Model T Ford or the 1901 Oldsmobile? You used a crank to start their engines.

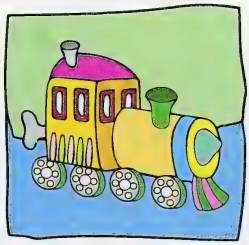
As the driver turned the crank on the car, great care had to be taken. You did not wrap your fingers and thumb around the handle; the crank had to be pulled up, not pushed down. If you were careless, the crank could kick back and break your thumb, or worse—your shoulder!

If you look around your home, you'll find many things around you that are powered by a crank.

Some large-drum pencil sharpeners have a crank for you to turn. Can you find one of these?

With adult help you can take off the drum. Now, watch things move in the sharpener as you crank the handle.

In the kitchen, you may find such things as a salad spinner or an ice-cream maker. In your toy box, you may have wind-up toys such as cars or a jack-in-the-box. Some watches, alarm clocks, and wall clocks still use a winding device to keep them working.

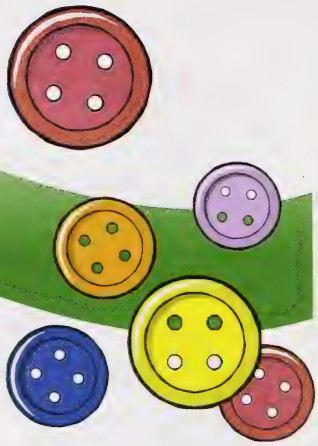


The cranking motion in items such as these can serve two purposes:

- It can cause the inner workings to move; the cranking directly powers the device. A pencil sharpener, salad spinner, and ice-cream maker work this way.

- Cranking can also be used to store up energy within the item. A spring or elastic inside can store up energy to be released when needed. A watch or wind-up toy work like this.

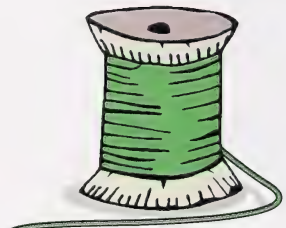
Activity 3: Driving a Spool



In this activity, you will be using a winding mechanism to store energy in a device. This device will then use the energy to move.

What you need

- a spool, preferably with notched ends (from sewing thread)
- 2 toothpicks or wooden matchsticks (one long and one short) **or** a short piece of toothpick and a bobby pin
- a rubber band (as long as the width of the spool)
- a small washer or a button with large holes
- a short piece of tape



What to do

1. Put the rubber band through the hole in the spool, and put the short toothpick through one of the loops made by the rubber band. To hold the toothpick in place, put a short piece of tape across this end of the spool.

2. Push the other loop of the rubber band through the washer or a hole in the button. Put the long matchstick (or toothpick or bobby pin) through this loop on the outside of the washer or button.

3. Wind up the elastic band by turning the long toothpick. Firmly hold the spool while you are winding up the band.

4. Lay the spool on the ground, and let go.

5. Repeat this experiment on a variety of surfaces.

   a. What happened when you let go of the spool?

   _____

   _____

   b. Did the spool react differently on different surfaces? Explain.

   _____

   _____

Check your answers for this activity in the Suggested Answers at the end of this lesson.

Can you imagine turning a crank to listen to your favourite music? In the late 1800s you had to have strong arms to listen to music!

Emile Berliner designed a zinc disc that had to be cranked at exactly 70 rpm (revolutions per minute). You would have to turn the crank at this rate through the whole song. Someone would have to hold the phonograph steady for you too. Otherwise, the needle could be jolted by the cranking movement. Then the song would skip and the disc could be damaged!

Turn to Assignment Booklet 2A and complete question 3 of the Section 1 Assignment.

Suggested Answers

Activity 3: Driving a Spool

5. Repeat this experiment on a variety of surfaces.

a. What happened when you let go of the spool?

The spool should roll along the ground.

b. Did the spool react differently on different surfaces? Explain.

The spool would roll better on a surface with better traction and less interference (for example, plush carpet and linoleum could be a problem).

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

28 **top:** © 2005–2006 www.clipart.com

29 **top:** "© 2006 Jupiterimages Corporation"
remainder: © 2005–2006 www.clipart.com

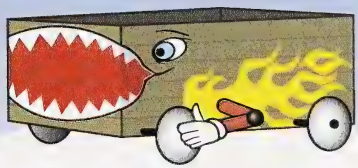
30 **spool and buttons:** © 2005–2006 www.clipart.com

31 © 2005–2006 www.clipart.com

32 © 2005–2006 www.clipart.com

Section 1

Conclusion



In this section, you have explored forces that cause motion. You have used these forces to make certain actions easier; for example, you saw that fast-running water cleans dishes quicker and more easily than slow-running water.

Now you can volunteer to do the dishes and you know how to get the job done quickly and efficiently!

Now turn to the checklist in Assignment Booklet 2A and make sure you have collected everytyhing to send to your teacher. Also, be sure to fill out your Student Feedback Form.

Optional Follow-up Activities

Activity 1: Drop It!

Which falls faster—a golf ball or a tennis ball? Because of gravity, both objects fall down to the ground. Does one ball fall faster than the other?

Do this activity with an adult helper.

What you need

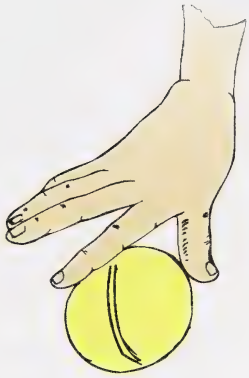
- 2 balls of different sizes and weights (could be a tennis ball and a golf ball)
- other pairs of unbreakable items of the same shape but different weights
- a cookie sheet (for the objects to land on)
- a sturdy chair

What to do

1. Set the cookie sheet on the floor.
2. Stand on a chair above the cookie sheet.
3. Hold the balls at the same height and over the cookie sheet. (The balls should land in the pan.) Drop the two balls at the same time.
4. Listen for the sound of each ball hitting the cookie sheet.

5. What happened?

6. Try the experiment again with pairs of other items. Try to keep the items the same shape (both spheres, both rectangular prisms, and so on) but different weights.

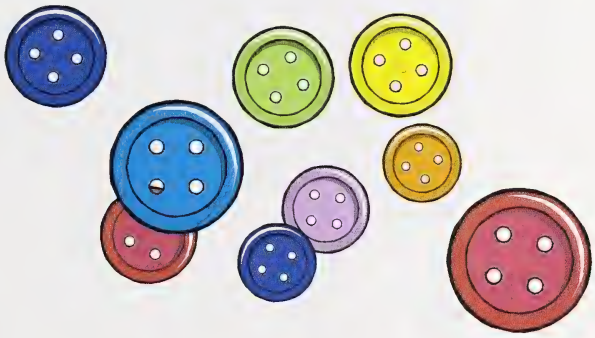


7. What happened?

Activity 2: Spool Races

Construct another spool device (see Section 1: Activity 3). You may want to use a different size of spool or button. Challenge your home instructor or a friend or family member to a spool race!

You can try building a giant-sized spool device using the spool from a roll of ribbon. You could use a short pencil instead of the matchstick or bobby pin. Perhaps you'll be able to find an even bigger spool!



Section 2

A Designer at Work

Introduction

In this section, you will do the tasks a real designer does. You will design and build a machine. You will then test how well your machine works. You will check each part for problems.

You will also think of ways to improve any parts that do not work well. Designers test and retest all parts of their inventions. You, too, will test and retest each part of your burglar alarm. Testing will make a better machine.

Lesson 4: Design Work

Have you ever invented something? The world is full of people who invent things. Some of these inventions make our lives easier or solve a problem; others make our lives more interesting or fun. Some inventors love to create new things just because inventing is fun!

The word *inventing* describes the whole process of creating a new thing. Inventing includes the ideas you have in your head, the ideas you write down on paper, and the models you try to make.

Today you will think of an invention.

Most machines are designed to make work easier or to help you solve a problem. To design a machine you must first understand what is making the work difficult. You have to ask questions—lots of questions!

For example, you may find it hard to open a jar of your grandmother's pickles. As you struggle with the jar, you probably wonder why it is so hard to open.

You might ask yourself questions like these:

- Was the lid tightened too much?
- Is the lid stuck on the threads?
- Are my arms too weak?
- How can I get a better grip on the lid?

You probably also try to think of ways to solve the problem:

- What if I use a wet cloth?
- What if I run the lid under warm water?
- Can I loosen the lid if I hit it with something heavy?

Inventors have designed several devices to help people open tight lids. Ask your home instructor to help you find some of these devices.

When scientists and inventors set out to design something, they first define (explain or describe) the **problem** they want to solve. Some examples (these things have already been invented) are

- a car that doesn't create air pollution
- a mousetrap that doesn't kill the mouse
- a clothes iron that shuts off automatically

The next step is to write down everything they know about the problem. If they are designing a mousetrap, they might write down what mice eat, what their habits are, and what works and doesn't work with the mousetraps available now. They also might do some research to find out more about mice and mousetraps.

The third step is to write down questions that need to be answered. They may want to know where mice are a problem. They could need to know if the mice should be killed or kept alive. The questions help decide what has yet to be learned.

brainstorming: thinking of as many solutions to a problem as possible

Once questions about missing information are created, it is time for step four. Step four is a **brainstorming** session. Brainstorming is a way of coming up with ideas. Scientists and inventors will sometimes talk with a group of people. This helps them come up with ideas to solve the problem. Sometimes, they may work alone.

Solving Problems

Here are the first steps of a plan for solving a problem.

Step 1
Describe the problem.

Step 2
List information you know.

Step 3
Ask questions for investigation.

Step 4
Brainstorm for ideas to help solve the problem.

Follow the problem-solving plan in the example of "The Missing Cookies."

Step 1: Describe the Problem.

Do you need something to make your life easier or more interesting or more fun? Do you need something to help you solve a problem? Ask yourself many questions. Decide exactly what idea you need to work on.

The problem in this example is that someone keeps taking cookies from the cookie jar. You need to find out who that person is.

Step 2: List the Information You Know.

Think carefully about all the information you know about the problem. You may have to do some research.

- The cook baked two dozen cookies yesterday morning.
- The cook ate two cookies.

  When it was time to serve the cookies for an evening snack, there were only one dozen cookies in the cookie jar.

- The cook went shopping from noon until 1 p.m. and worked in the garden from 4 p.m. to 6 p.m.

  The cookie thief could have come at either of these times.

- Before the cook worked in the garden, there was dirt all over the path.
- There were no footprints in the kitchen.
- The thief must have come between 4 p.m. and 6 p.m., or the thief would have left footprints in the house.
- If the cookie thief had been in the cookie jar, he or she would have had sticky fingers.

- The cook did not see fingerprints on any window, so the cookie thief must have left through the door.

Step 3: Ask Questions for Investigation.

Review your information. What questions will you need to investigate in order to solve your problem? You may ask questions like these:

- How is this cookie thief getting into the kitchen?
- When is he or she getting into the kitchen?
- Why does the cook never see the cookie thief?
- How could the cook be alerted when the thief is coming?

Step 4: Brainstorm Ideas for Solving the Problem.

Brainstorm by yourself or with friends and family for ideas that will solve the problem. No idea is too silly. Write down as many ideas as you can. Here are some ideas:

- Put a mouse trap in the cookie jar.
- Hide in the bushes and watch for the thief.
- Stop making cookies.
- Lock the door when in the garden.
- Make a burglar alarm.

You will look at a good way of organizing your problem-solving ideas in Activity 4: Problem Solver.

Activity 4: Problem Solver

mind map: a way of describing a problem using key words and pictures

You will make a **mind map** about the problem of the missing cookies. Using a mind map is a good way to organize your problem-solving ideas. Follow the given steps to create your mind map.

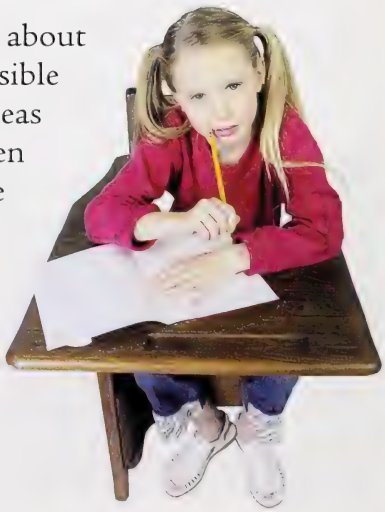
What to do

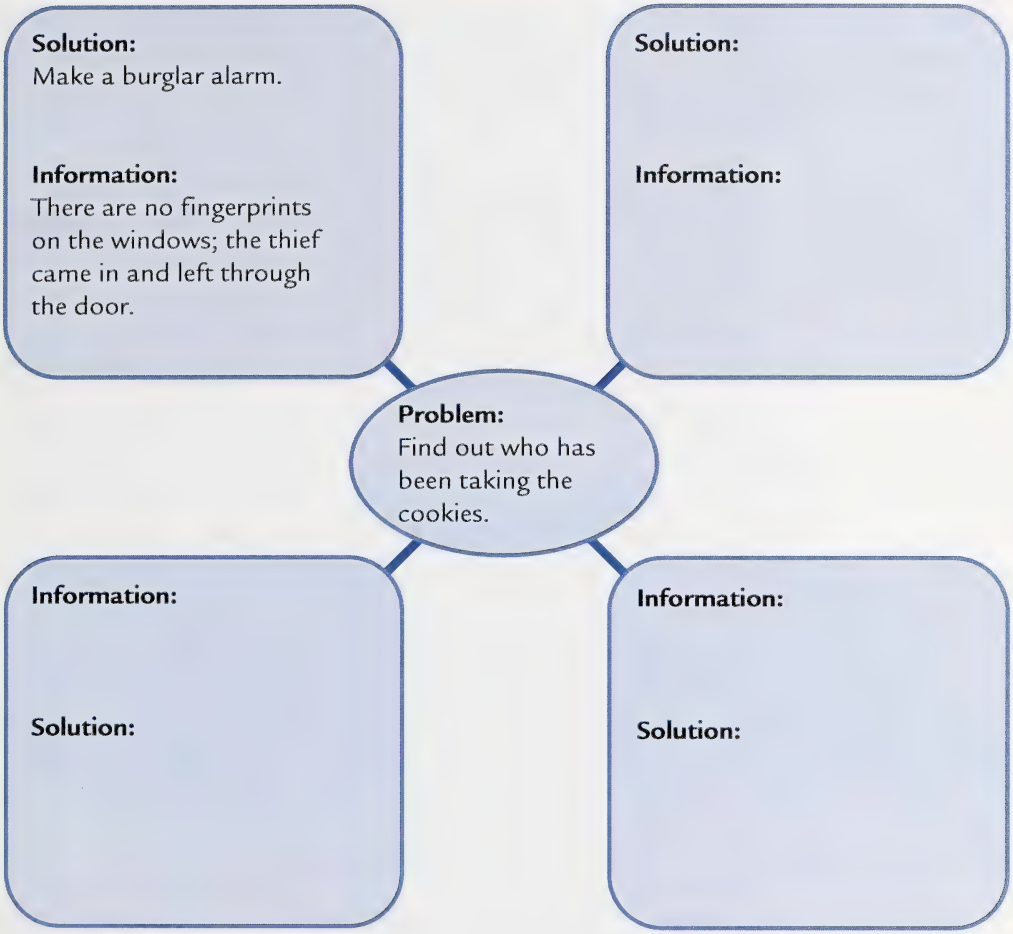
1. Use the **mind map** on the next page to do this question.

   a. Use the middle circle to describe or explain the problem. The problem has been filled in for you.

   b. What do you already know about the problem of the missing cookies? Fill each outside circle with some information you can think of about this problem. Use a new circle for each idea. One circle has been filled in for you.

   c. Using what you already know about this problem, brainstorm possible solutions. Do not leave out ideas that seem silly. Sometimes even silly ideas can be useful. Some ideas are stepping stones to other ideas. In each outside circle, write a possible solution for the piece of information. One circle has been filled in for you.





2. Carefully consider each of your possible solutions. Which idea is the best one to help you solve your problem?

_____

_____

Check your answers for this activity in the Suggested Answers at the end of this lesson.

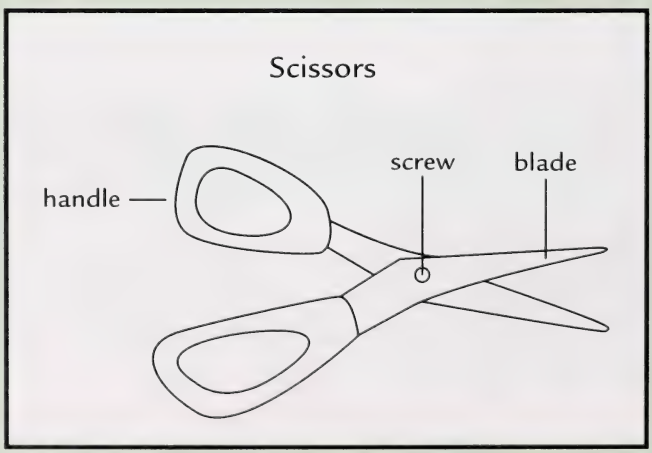
Now get ready to design your solution on paper. It is easier to figure things out with a pencil first. You can always use an eraser as you think of ways to improve your design!

A Scientific Drawing

A scientific drawing is a clear way to explain something. It is often easier to draw a picture than it is to use words to describe something. Scientific drawings should be clear, neat, and accurate. Follow these steps to make a scientific drawing:

- Use unlined paper and a pencil.
- Make your drawing simple and clear.
- Your drawing should be large enough to show details and also allow space for labels. Label all parts of the drawing.
  - Write your labels in lower-case letters.
  - Use a line, not an arrow, to point to parts of your drawing.
- Use colour only if necessary. If you use colour, choose colours that are as close as possible to the actual colours.
- Give your drawing a title.

Here is one example of a scientific drawing.



You will now continue trying to find a solution to the missing cookie problem. Here are the next steps in solving a problem. Follow these steps in the continuing example of "The Missing Cookies."

Step 5
Choose one of the solutions you brainstormed.

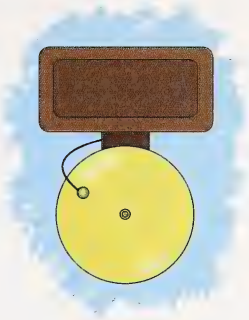
Step 6
Think about your design.

Step 7
Brainstorm ideas about how you can use one or more simple machines to help solve your problem.

Step 8
Make a plan to build the machine.

Step 9
Make a simple drawing of your machine.

Step 5: Choose a Solution.



Pick the idea that you feel is the best one to help you solve your problem.

- Make a burglar alarm.

Step 6: Think About Your Design.

Think about how your design will look and how it should work.

- First, think about how the burglar alarm could look and how it might work. For example, the burglar alarm should go off when the thief opens the door to the kitchen. It must be loud enough to be heard from the garden.

Step 7: Brainstorm Ideas.

Brainstorm ideas about how you can use one or more simple machines to help solve your problem.

- If marbles roll down a ramp into a metal pan, they will make noise.
- If a string is tied to the door handle, it will move when the doorknob turns or the door opens.
- If the string is attached to the ramp, it can lift one end of the ramp and tip out the marbles.
- The string can go from the doorknob to a pulley near the ceiling. Then it can be tied to the end of the ramp, near the floor.

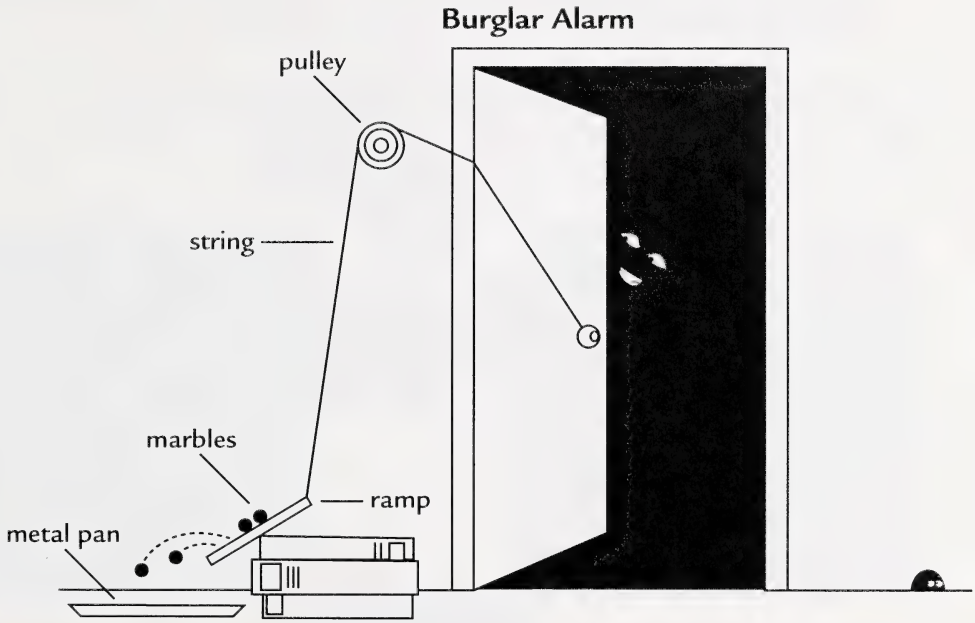
Step 8: Make a Plan.

Make a plan to try your solution idea.

- The cook will make fresh cookies.
- Between 4 p.m. and 6 p.m., the doorknob will turn. It will pull the string.
- The string will go from the doorknob through the pulley and down to the ramp.
- When the door moves, the string will move and lift one end of the ramp.
- The marbles will roll into a pan and make noise.
- The cook will hear the noise and catch the cookie thief.

Step 9: Make a Drawing.

Make a simple drawing of your design. You can follow the information given in A Closer Look: A Scientific Drawing. Here is an example.



Turn to Assignment Booklet 2B and complete question 4 of the Section 2 Assignment.

Suggested Answers

Activity 4: Problem Solver

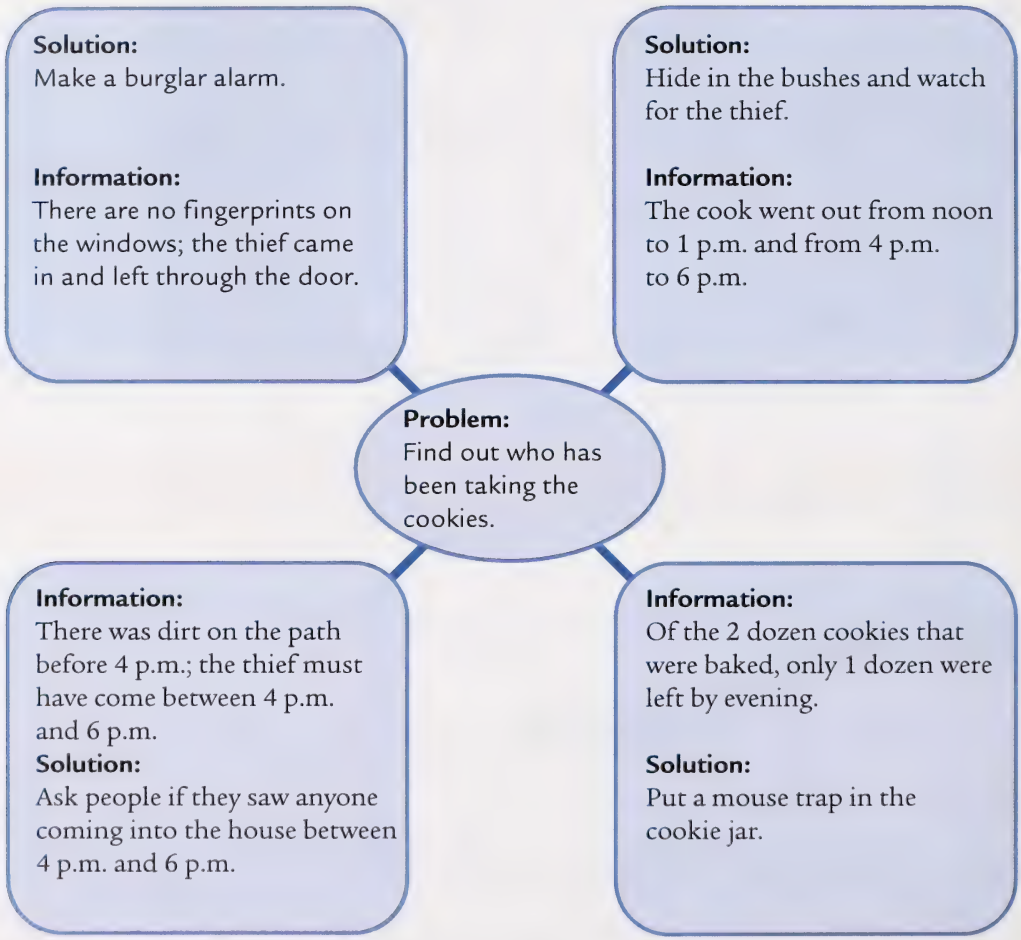
1. Use the **mind map** on the next page to do this question.

a. Use the middle circle to describe or explain the problem. The problem has been filled in for you.

b. What do you already know about the problem of the missing cookies? Fill each outside circle with some information you can think of about this problem. Use a new circle for each idea. One circle has been filled in for you.

c. Using what you already know about this problem, brainstorm possible solutions. Do not leave out ideas that seem silly. Sometimes even silly ideas can be useful. Some ideas are stepping stones to other ideas. In each outside circle, write a possible solution for the piece of information. One circle has been filled in for you.

You will take the information given in the missing cookies problem and put it into a mind map. You may also have different ideas in your mind map. Here is one possible example.


Solution:
Make a burglar alarm.
Information:
There are no fingerprints on the windows; the thief came in and left through the door.
Solution:
Hide in the bushes and watch for the thief.
Information:
The cook went out from noon to 1 p.m. and from 4 p.m. to 6 p.m.
Problem:
Find out who has been taking the cookies.
Information:
There was dirt on the path before 4 p.m.; the thief must have come between 4 p.m. and 6 p.m.
Solution:
Ask people if they saw anyone coming into the house between 4 p.m. and 6 p.m.
Information:
Of the 2 dozen cookies that were baked, only 1 dozen were left by evening.
Solution:
Put a mouse trap in the cookie jar.

2. Now look at your possible solutions. Consider each one carefully. Which idea do you think is the best one to help you solve your problem?

You may have chosen any one of the possible solutions from your mind map.

Key Words

brainstorming: thinking of as many solutions to a problem as possible

mind map: a way of describing a problem using key words and pictures

Image Credits

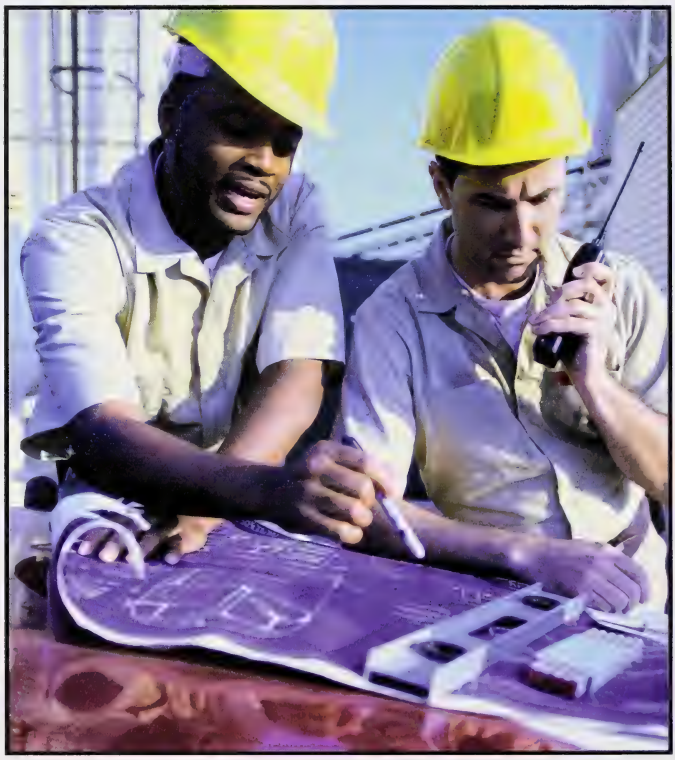
All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

37 **both:** © 2005–2006 www.clipart.com
38 © 2005–2006 www.clipart.com
39 Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.
40 **both:** © 2005–2006 www.clipart.com
41 Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.
42 © 2005–2006 www.clipart.com
46 © 2005–2006 www.clipart.com
49 © 2005–2006 www.clipart.com

Lesson 5: Designing a Machine

Engineers design buildings and many types of machines. They use science in their work. Get out your measuring tape. Stick a pencil behind your ear. Pretend you are an engineer. Are you ready to build a machine?

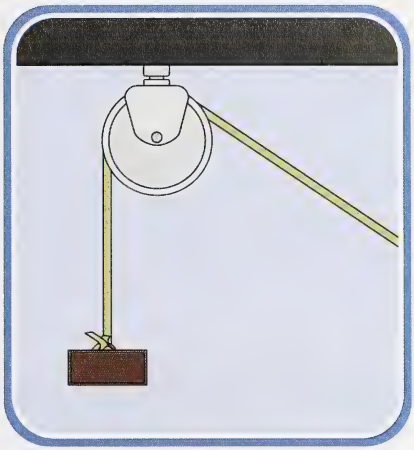


In this lesson and the next few lessons, you're going to design, build, and test a machine. You will build the burglar alarm that you described in the Lesson 4 assignment.

Now is the time to look more closely at each part of the burglar alarm. How will it work? What materials will you need?

Your design had to have a pulley. Consider the pulley in your plan.

- How will the pulley look?
- What material will be used for the pulley wheel?
- What will be used to pull up the weight?



Activity 5: Designing with Pulleys

What to do

1. Use the space below to draw the **pulley system** for your burglar alarm. Label each part.

2. Describe the materials you will use for the pulley system. What will the pulley wheel be made of? What type of string or rope will be used to make the loop?

_____

_____

_____

_____

Check your answers for this activity in the Suggested Answers at the end of this lesson.

Think about the materials you will need for your burglar alarm.

Talk to your home instructor about your plans.

Question 5 of the Section 2 Assignment will ask questions about the design of your burglar alarm. You will be considering questions such as the following:

- What will the pulley be attached to?
- How will it be attached?
- What materials will be used to attach the pulley?
- How long will the rope on the pulley need to be?
- What will create the sound for the alarm?
- What materials will be used to create the most noise?
- What other simple machine will be used in the burglar alarm?
- How will this simple machine be created?
- What will you use to make it?

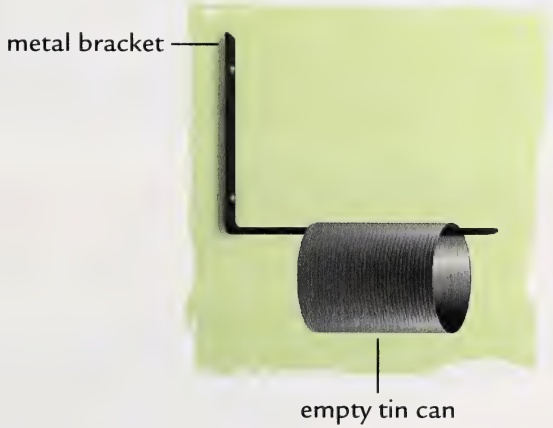
Turn to Assignment Booklet 2B and complete question 5 of the Section 2 Assignment.

Suggested Answers

Activity 5: Designing with Pulleys

1. Use the space below to draw the **pulley system** for your burglar alarm. Label each part.

Your design will vary depending on the materials you choose. You may have a pulley design that looks like the picture below.



2. Describe the materials you will use for the pulley system. What will the pulley wheel be made of? What type of string or rope will be used to make the loop?

Answers will vary. You could use the spool from sewing thread or a roll of ribbon, a small can that has both ends removed, or a toilet-paper roll for the pulley wheel. The pulley needs a firm, unbendable axle, such as a piece of heavy wire, a chopstick, a pencil, a piece of dowel, or other cylinder-shaped object.

You could use heavy kitchen string or butcher's string for the loop. A lightweight nylon rope could also be used.

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

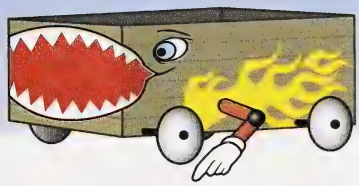
Page

50 Eyewire/Getty Images

52 Brand X Pictures/Getty Images

Section 2

Conclusion



You have made the first step towards becoming an inventor. You looked at a problem, and made a plan for a machine to solve that problem. Sometimes inventors get to this stage and go no further. They continue to develop plans, until they find one that really interests them, and then they go to the next step. In Section 3, you will be taking your plan to the next step.

Remember to complete all of the assignment questions for Section 2 in Assignment Booklet 2B. Also, if you like, choose one of the Optional Follow-up Activities to send in as well.

Optional Follow-up Activities

Activity 1: Invention Drawing

Do you like to draw? Draw a cartoon of an imaginary invention. Include several simple machines in your drawing. The invention doesn't need to be practical. You might find some ideas at the following website:

http://www.rubegoldberg.com

Activity 2: Invention Collage

Use old magazines and catalogues to find pictures of inventions you like or that you feel are very useful. Make a collage of these pictures on a piece of plain paper or construction paper.

Activity 3: Machine Search

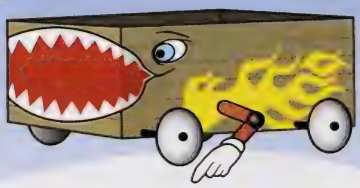
Look at the pictures on the following page. Put a circle around each simple machine as you find it. How many simple machines can you find?

For an extra challenge, ask your home instructor to time you for 5 minutes. Can you find at least ten simple machines in 5 minutes?

MARKET
Organic Sale

Section 3

Building and Refining the Design



Introduction

In this section, you are going to build a machine and test it. You will test how well your machine works, and you will check each part for problems. You will also think of ways to improve the parts that don't work well.

Testing makes better machines. People who make machines check each part to see how it works. If there is a problem, they will want to fix it. This testing and retesting makes safer, more reliable machines.

Lesson 6: Testing, Testing

There is a saying that a chain is only as strong as its weakest link. What does the saying mean? Chains are made of many small parts called links. If one link breaks, the chain breaks. Suppose there were 4999 strong links and 1 weak link. Would this be a strong or weak chain?

You could say the same thing about a machine. A machine is only as good or strong as its weakest part. After you design and construct a machine, it is important to test it. You want to make sure each part is strong and works well.

Did you ever get something that did not work or that broke right away? Some things have trouble spots—a single part that is likely to break or wear out. Knowing about forces and structures can help you predict a trouble spot. A poor choice of materials, design, or construction can cause a trouble spot.

predict: to guess what is going to happen beforehand

Sometimes you can see a trouble spot right away. For instance, a plastic spoon may not be strong enough to dig into hard ice cream. You can see the spoon bend when force is applied. You can tell it is not strong enough for the task. In this case, it is a poor choice of material. The plastic is not strong enough. A metal spoon the same size and shape would not bend.

Imagine

Did you know that factories check bathtubs? The finish on a bathtub is tested by having 34 different chemicals poured into the tub. The chemicals range from gasoline to mustard. The test checks whether these chemicals will cause stains in the tub.

There is also a scrubbing test on bathtubs. Mechanical brushes and cleansers scrub the tub 10 000 times. That's equal to cleaning the tub once a day for over 27 years! This shows if the tub's finish is long lasting.

Testing can be very simple. First, you look at how the machine or object will be used. You look at each part of the machine or object and test it over and over again.

For example, to test a toaster you might press the handle down a hundred times. If the handle doesn't work well, its design may need to be changed. You could also test the toasting elements by making 1000 pieces of toast. Each piece of toast should be golden-brown. If the toast burns, the design of the toasting elements may have to be changed.

Cars are tested to see what happens to them and the people in them when there is a crash. The tests usually destroy the cars used in the trials.

In car crash tests, cars are driven into walls or other cars at different speeds. Crash-test dummies are used instead of people. These dummies have many sensors in them. Testers examine the dummy to see how well protected it was. Did the seat belts and the air bags protect the dummy during the crash?

You can find out more about crash testing at the How Stuff Works website.

http://auto.howstuffworks.com/crash-test.htm

You have seen that a design must be tested in order to find any weak parts or parts that do not work well.

If you were building a bird house, for example, you would have to test your design in order to attract the birds you want. Bird houses must be a certain size and colour. The entrance has to be the right size. The house has to be put at the right height and in the proper location. If any part of your design doesn't work properly, you will have to change it.

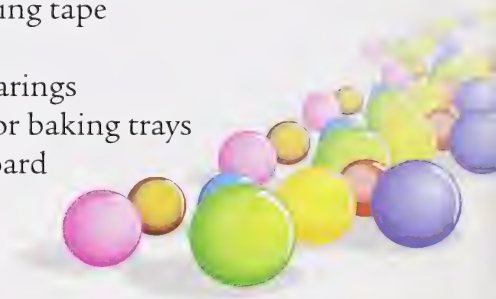
Activity 6: Building and Testing

You have seen that creating something takes a lot of planning and work. You now have your list of materials for building your burglar alarm. It is time to put them together.

What you need

Collect the materials you chose in Lesson 5 as the best ones to build your burglar alarm. Your list might be similar to this one:

- metal coat hangers
- empty spools from thread
- butcher string
- duct tape or masking tape
- tacks
- marbles or ball bearings
- metal pots, pans, or baking trays
- corrugated cardboard
- hole punch



What to do

Be sure your home instructor agrees with your plan before you build this complex machine. Also discuss where you can set up your alarm.

1. Attach your pulley to the location you chose in your design. Use the method you chose in the Lesson 5 assignment.

2. Set up your noise-making device as you have described in the Lesson 5 assignment.

trigger: the thing that causes the alarm to go off

3. Attach the string (or other material chosen) to the trigger. Loop the string through your pulley, and attach it to the noise-making device.

4. Draw a sketch of your machine in the space below. Label each part.

Check your answers for this activity in the Suggested Answers at the end of this lesson.

Congratulations! You have finished building your machine. Remember to keep it for your next lesson.

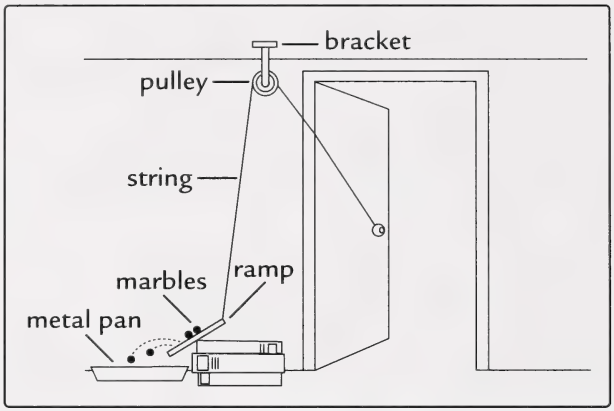
Turn to Assignment Booklet 2B and complete question 6 of the Section 3 Assignment.

Suggested Answers

Section 3: Activity 6

4. Draw a sketch of your machine in the space below. Label each part.

Answers will vary. Following is one possible design.



Key Words

predict: to guess what is going to happen beforehand

trigger: the thing that causes the alarm to go off

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

59 **bottom:** © 2005–2006 www.clipart.com

60 **top:** "© 2006 Jupiterimages Corporation"
bottom: © 2005–2006 www.clipart.com

61 **both:** © 2005–2006 www.clipart.com

62 © 2005–2006 www.clipart.com

Lesson 7: Improving Your Machine

Any complex machine, such as your burglar alarm, is made up of many simple machines. How many simple machines can you see in and around this airplane?

Often during testing, you first look at each piece of the machine by itself. You look at it one simple machine at a time. Then, you think about how you can adjust the simple machines to make your device better.

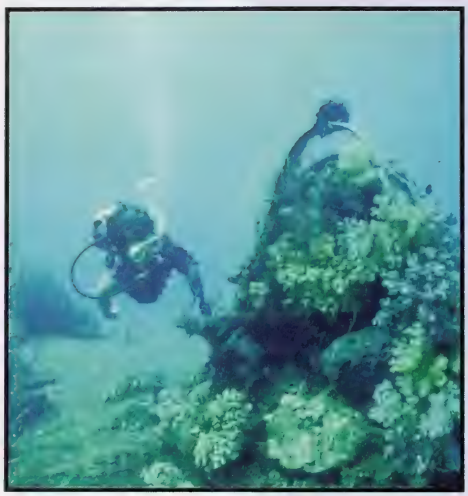
- Think about the forces involved.
- Think about the materials used.
- Think about where to place each part.

Before you begin testing and improving your machine, read about another inventor and problem solver.

A Great Scientist

Jacques Cousteau

You may know about the underwater filmmaker, Jacques Cousteau. Jacques Cousteau, with an engineer, Emile Gagnan, invented the Aqualung (scuba) in 1943. The scuba let people dive and breathe underwater. Cousteau designed the device to solve a practical problem. He didn't want to keep coming to the surface to breathe.



Cousteau helped design many other things:

- the Diving Saucer (a two-person submarine that could dive 300 m below the sea surface)
- the Sea Flea (a one-person submarine)
- the Conshelf (an underwater platform 100 m below the surface of the sea; six people could live and work here for three weeks at a time)

Cousteau made many films and wrote several books on the ocean. His work introduced people to the underwater world. Cousteau died in 1997 at the age of 87.
The Cousteau Society continues Jacques Cousteau's work. The Society helps to protect and preserve the environment.

To discover more about Jacques Cousteau's life and inventions, go to the Internet site for the Cousteau Society.

http://www.cousteau.org

Activity 7: Making a Better Burglar Alarm

In the Lesson 6 assignment, you tested and checked your machine. You checked its ability to solve the problem of catching a cookie thief.

Now it is time to try to improve your machine.

What you need

- your burglar alarm
- extra materials as required (tape, tacks, modelling clay, cardboard, and so on)

What to do

Discuss your design problems and possible changes with your home instructor. You want to be sure that the new design does not add any safety problems.

1. You need the answers you gave in question 5 of Assignment Booklet 2B. Copy each "Yes" and "No" answer by putting an X into the Making a Better Burglar Alarm chart.

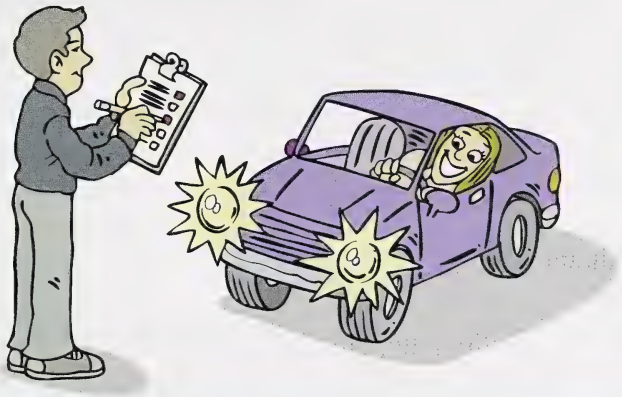
2. The chart asks questions about problems that you may have found in your machine. Use the questions to help you list improvements that you can make.

3. Did you have any other problems with your burglar alarm? List them in the empty spaces in the chart. Suggest how you could solve these problems in the "Improvements" column.

Making a Better Burglar Alarm			
Observations	**Yes**	**No**	**Improvements**
Did the string break or stretch?			
Was the string attached well to the trigger and to the noise-making device?			
Did the string run well through the pulley?			
Did the pulley come loose?			
Does any part of the alarm need to be moved to a different position?			
Was the noise loud enough to hear from a distance?			

Check your answers for this activity in the Suggested Answers at the end of this lesson.

You have looked at ways to make a device better. You can think about the forces involved, the materials used, and the placement of each part in the machine. You looked carefully at possible problems in your burglar alarm. You suggested ways you could improve your design.



Turn to Assignment Booklet 2B and complete question 7 of the Section 3 Assignment.

Suggested Answers

Activity 7: Making a Better Burglar Alarm

1. You need the answers you gave in question 5 of Assignment Booklet 2B. Copy each "Yes" and "No" answer by putting an X into the Making a Better Burglar Alarm chart.

2. The chart asks questions about problems that you may have found in your machine. Use the questions to help you list improvements that you can make.

3. Did you have any other problems with your burglar alarm? List them in the empty spaces in the chart. Suggest how you could solve these problems in the "Improvements" column.

1.–3. Answers will vary. Sample answers are shown in the chart on the following page.

Note: It is possible that your machine worked very well and few, if any, improvements are needed. Keep this chart. You will need it for Activity 8.

Making a Better Burglar Alarm			
Observations	**Yes**	**No**	**Improvements**
Did the string break or stretch?	X		Use stronger or more rigid string or rope.
Was the string attached well to the trigger and to the noise-making device?		X	Add tape, staples, or glue; tie tighter knots.
Did the string run well through the pulley?		X	Build "rims" on the pulley so the string doesn't slip off.
Did the pulley come loose?	X		Staple, tack, glue, or nail the pulley to its location.
Does any part of the alarm need to be moved to a different position?	X		The pulley needs to be placed higher above the noise device.
Was the noise loud enough to hear from a distance?		X	Have the objects crash against each other from a greater height.
Could the string move the noise-making device?		X	Use less heavy materials for the noise device.

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

65 Photodisc/Getty Images

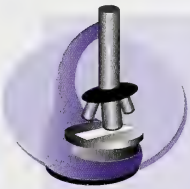
66 **photo:** "© 2006 Jupiterimages Corporation"
fish: © 2005–2006 www.clipart.com

67 **top:** © 2005–2006 www.clipart.com

69 © 2005–2006 www.clipart.com

Lesson 8: Final Testing

You have worked hard on planning, building, and testing your machine. Most inventors spend hours in labs, testing their inventions. You have tested your machine once. You have corrected any problems. Today it is time for the final test!

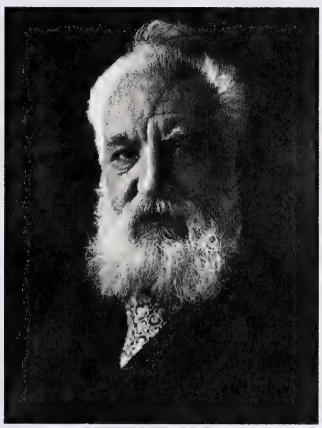


A Great Scientist

Alexander Graham Bell

"All really big discoveries are the result of thought."

Alexander Graham Bell invented the telephone while he lived in Canada. He said that every inventor wants to improve whatever he sees. Inventors want to benefit the world.



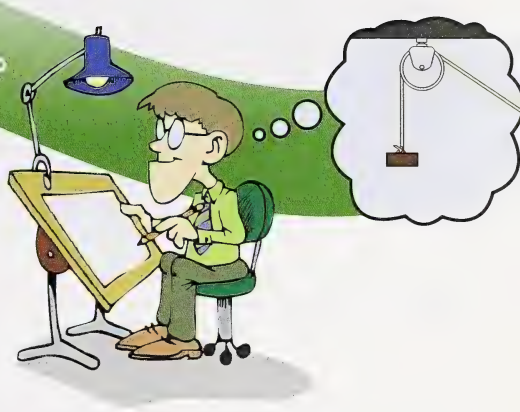
Do a search on the Internet using "Alexander Graham Bell." You will find out more about his many inventions.

Are you enjoying being an inventor? Today you will perform the final test on your burglar alarm. Before you do this, remember the reason you built it. It is easy to get so involved in your invention that you forget its purpose. You cannot judge the machine without considering its purpose.

Your machine is a burglar alarm. You designed it to make noise when the cookie thief enters the house. If this machine works, you may need to use it only once. It is not the same as a toaster. You do not have to test it a thousand times. However, when the cookie thief comes, the alarm must work. The purpose is to catch the cookie thief.

In the final testing, it is important that the machine works every time. You must carefully judge your machine. Remember, a machine is only as strong as its weakest part.

Activity 8: Are We Done Yet?



What you need

- your improved burglar alarm

What to do

In Lessons 6 and 7, you described some changes you might make to your machine, the burglar alarm. If you have not yet done so, make these changes.

The chart on the next page continues the chart you filled in during Activity 7. Follow steps 1 to 4 to complete the chart.

1. In the first column, write down only the observations that led to changes.

2. In the "Improvements Made" column, write down the changes you made.

3. Test your machine. Put an X under "Yes" or "No" to show whether or not your improvement worked.

4. Study the parts of your design that still have problems.

   If your changes did not make the burglar alarm work better, write down a different idea about how you might fix the problem. Put your idea in the "Ideas for Further Improvement" column. One example of a possible answer is shown in the chart.

Making a Better Burglar Alarm				
Observations	Improvements Made	Did it work?		Ideas for Further Improvements
		Yes	No	
Did the string break or stretch?	Butcher string was used.	X		Use nylon cord.

Check your answers for this activity in the Suggested Answers at the end of this lesson.

Remember, testing and retesting will help make a better, safer, and more reliable machine.

Turn to Assignment Booklet 2B and complete question 8 of the Section 3 Assignment.

Suggested Answers

Activity 8: Are We Done Yet?

1. In the first column, write down only the observations that needed fixing.

2. In the "Improvements Made" column, write down the changes you made.

3. Test your machine. Put an X under "Yes" or "No" to show whether or not your improvement worked.

4. Study the parts of your design that still have problems.

If your changes did not make the burglar alarm work better, write down a different idea about how you might fix the problem in the "Ideas for Further Improvement" column. One example of a possible answer is shown in the chart.

1.–4. Answers will vary for this summary chart. Additional improvement ideas are needed for any part of the design that doesn't work well. You may have to try extra ideas for some parts of your machine.

Discuss your answers with your home instructor. You may brainstorm together for further ideas.

Image Credits

All images in this lesson were created by or for Alberta Education with the following noted exceptions:

Page

71 **top right and phone:** © 2005–2006 www.clipart.com
bottom: "© 2006 Jupiterimages Corporation"

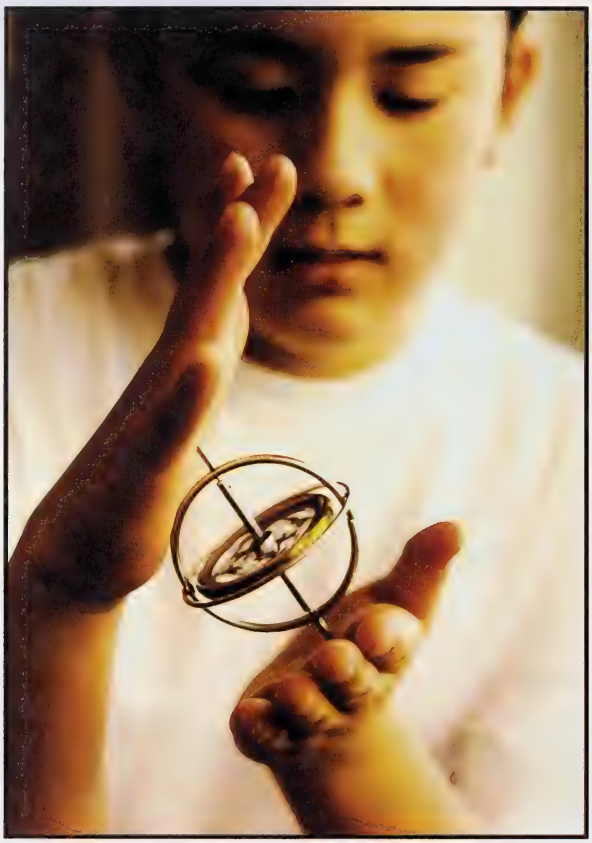
72 Art Parts/Ron and Joe, Inc (www.ronandjoe.com). Used by permission.

73 **designer (not including bubble content:** © 2005–2006 www.clipart.com

Section 3

Conclusion

Congratulations! You have designed, built, and tested a machine. Did you discover that there are more steps to making a machine than you first thought?



It is important to have a good idea and a good design for an invention. It is also important to test and improve your invention as you create it. This way you will end up with an excellent machine by your final test. Good work!

Optional Follow-up Activities

Activity 1: Come Back to Me!

The power stored in this device will have surprising results.

Ask an adult for help with the drill. Work carefully; there are sharp metal edges.

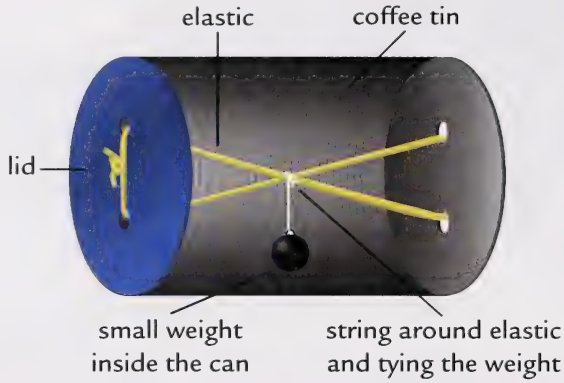
What you need

- an empty coffee tin with a plastic lid
- a drill with a 5-mm bit
- a length of narrow (about 5 mm wide) elastic
- kitchen string or cord
- a small weight that can be tied securely to a string

What to do

- Drill two holes about 50 mm apart in the lid of the tin.
- Mark and drill two matching holes in the base of the tin.
- Carefully thread the elastic through the base holes.
- About halfway down inside the tin, bring the two sides of the elastic together and tie them with the string.
- Now use the string to tie the weight tightly to the elastic. Thread each elastic piece through a hole in the lid. Put the lid on the can, and tie off the two ends.

Your assembled device will look similar to this:



- Roll the tin away from you, on a flat smooth surface. Observe the results. Try rolling the tin away from you down a gradual slope or on a surface that is not smooth. Observe the results.

1. What happened when you rolled the can away from you on a smooth surface? Was there any difference in what happened when the surface was not smooth?

2. Did the can behave in the same way when you rolled it down a gentle slope?

3. Why do you think this device behaves the way it does?

Activity 2: Getting Answers

Find out more about scientists and inventors. Get answers to science questions that puzzle you. Try doing a science project that interests you. Visit one or both of these Canadian magazine sites for some new science adventures:

- KNOW: The Science Magazine for Curious Kids
  http://www.knowmag.ca/

- YES Mag: The Science Magazine for Adventurous Minds
  http://www.yesmag.bc.ca/

Module Summary

Aren't machines wonderful? Can you imagine your world without any machines? In this module, you have seen examples of how inventors take everyday problems and design a solution.

Sometimes inventors are laughed at when they begin to dream of a new creation. When people began to dream of flying, they were laughed at. It took many years, and a lot of testing, redesigning, and retesting, but flying became a reality.

Did you enjoy your experience as an inventor? If so, you may want to read about other inventors and how they came up with their designs.

Now turn to the checklist in Assignment Booklet 2B and make sure you have collected everything to send to your teacher. Also, be sure to fill out your Student Feedback Form.

Glossary

brainstorming: thinking of as many solutions to a problem as possible

force: a push or a pull acting on an object

friction: a force that opposes the motion of an object

generator: a machine that changes water power, steam power, or other kinds of mechanical energy into electricity

gravity: a force of attraction between objects

inertia: the tendency of objects to remain in motion or to stay at rest

mind map: a way of describing a problem using key words and pictures

physics: the science that studies matter and energy, and how they interact

predict: to guess what is going to happen beforehand

resist: to act against an applied force

trigger: the thing that causes the alarm to go off

turbine: a large wheel rotated by the force of moving steam, water, or other fluid

© 2006